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Energy and Cost Analysis in Pulp and Paper Industry by Auditing Techniques: A Case Study

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Abstract

Men's quest for comfort and luxury has increased the demand for energy. So, the energy conservation has become essential to overcome the mounting problems of energy crisis. Efficient energy management, conservation of resources, carbon capture should be considered to solve out energy and environmental issues. In last 25 years, the world energy demand has increased by 70% and still increasing at a higher rate annually. Reduction of energy consumption and environmental issues can be achieved through adoption of environment friendly technologies such as massive plantation, rain water harvesting, use of treated effluent for irrigation and by auditing technologies etc. In the present case study of a pulp and paper industry, the energy auditing for Pumps, Barometric leg of washers, Agitator, Coal fired boilers, Dryer head of steam cylinder has been carried out using energy Level- I (The Walk Through) and Level- II (Standard) auditing techniques. It has been observed in case of pumps, that 50% energy and cost can be saved by replacing the 60 HP pumps with high efficiency 30 HP pumps for the same workload. In case of washers if >10 m barometric leg is provided then there is no need for the vacuum pumps (2x60 HP), installed for washers. So the total cost and energy consumption over these two pumps can be reduced. Interlocking system for agitators was suggested to avoid continuous running of agitators during paper machine shut down period, and thereby saving 41.7 % energy. TDS blow down valve in place of manual valve can prevent 0.5% blow down losses in case of coal fired boilers. By insulating the dryer head of steam cylinders the estimated energy saving potential is 3.5% and

investment cost for insulating (app. Rs. 2.0 lakh), can be paid back in 5-6 months.

Keywords: Paper industry, energy audit, pumps, boiler.

1. Introduction

Men's quest for comfort and luxury has increased the demand for energy. So, the energy conservation has become essential to overcome the mounting problems of energy crisis. Efficient energy management, conservation of resources, carbon capture should be considered to solve out energy and environmental issues. Electricity/power plays a crucial role in economic growth of any country. In today's world, energy is very precious and world energy demand has increased by 70% and still increasing at a higher rate annually. At present, as per NPCIL report 2011-2012, India is 4th largest consumer and 5th largest producer in the world. As reported on November 2011 the installed capacity of electric power generating stations in India under various electrical utilities was 185.5 GW, yet 40% of population has no access to electricity and 60% is firewood dependant. It is forecasted that upto 2032 India will be 3rd largest consumer of electricity, and the demand for energy will increase 4 times which is 200,000 MW at present (www.wikipedia.com).

The share of different type of energy generating stations is as follows:

Thermal power plants - 115649.48 GW (N N R Mendis et al, 2006), Nuclear power plants - 4.8 GW (V. Khadkikar and B. Singh, 2006), Hydro power plants - 37367.4 GW (N N R Mendis et al, 2006), Renewable Energy Source - 22.4 GW.

Large energy consumption was reported, such as the electricity and heat needed for chemical pulping, paper and pulp drying, black liquor evaporation and other operations in pulp and paper industry. Furthermore, the pulp and paper industry is an industrial sector with the potential for creating large energy savings (Browne and Williamson, 1999; IEA, 2007, H.W. Chen et al, 2012). Energy consumption and environmental issues can be achieved through adoption of environment friendly technologies such as massive plantation, rain water harvesting, use of treated effluent for irrigation and by auditing technologies etc. It can be achieved by adequate rating of equipments, using high efficiency equipments and change of habits which causes wastage of energy. The present case study reports the energy audit on five selected sections of a paper mill.

1.1 Energy Audit

The auditing activities include, Identification of all energy systems, Evaluation of conditions of the systems, Analysis of impact of improvement to those systems and Preparation of energy audit report. The cost/economic analysis is to be done after the audit work. The economic analysis provides the potential savings through audit in terms of cost. On the basis of audit results the essential steps can be taken in terms of quality control, cost effective maintenance etc. to improve production, safety and

economic utility activities (Singh et al, 2012).The following types of energy audit systems are used in industry (Alajmi A. 2012; Dall'O' et al, 2012):

1.1.1 **Level-*1* (The walk-through) audit: *1*** (The walk-through) audit: The walk-through audit is a tour of the facility to visually inspect each system. The walk through includes an evaluation of energy consumption data to analyze energy use quantities and patterns, as well as to provide comparisons with industry averages or benchmarks, for similar facilities. This is the least costly

***1.1.2 Level*-2** (Standard) audit: The standard quantifies energy use and losses through a more detailed review and analysis of equipments, systems, operational characteristics and onsite measurements and Testing.

1.2. Audited sections in paper industry: present case study

1.2.1 Pumps: Pumps are the most important rotating equipment for the transfer of water, Pulp, Chemicals, effluent etc. in paper industry. Now by the use of this type of audit .There exists a good scope to improve the pump efficiency and consequently reducing energy cost

1.2.2 Barometric leg of Washers: It is a multi-stage rotary vacuum washer system containing number of units working in series. Each unit of the vacuum washer consists of a wire cloth covering cylinder that rotates in a vat containing the pulp slurry. Vacuum is applied from the inside of the cylinder and a pulp mat is formed on the surface of the cylinder when in the vat. The wash water and the pulp flow in the opposite directions which are known as concurrent washing. By the above auditing techniques, it was suggested to remove the two vacuum pumps.

1.2.3 Agitator: During the audit it was observed that some of the agitators in the stock preparation were being run continuously during paper machine shutdown and it is recommended to provide inter lock with the transfer pumps to optimize power consumption.

1.2.4 Dryer head of steam Cylinders: It was observed that dryer head of steam cylinders of both paper machine and pulp sheeting machine were not insulated thereby increasing heat loss from the dryer heads. It is recommended to insulate the dryer cylinders exposed to working area to avoid convection losses.

1.2.5 *Coal fired boilers*: During the survey it was observed that due to salts present in the water, the scaling of the boiler surface leads to 1mm thick scale on the water side of the boiler resulting in the Downtime reduction, Costly demineralised water was saved, by replacing manual blow down valve with TDS blow down valve. The observed data for the audited section

1.3. Observation and analysis:

2.3.1 *Pumps:* Two sets of pumps of 60 HP were used.

Total no. pumps in the industry = 4,Energy consumed by existing pumps = 240 H.P.

Energy saved in each pump =30 H.P. (by applying same capacity but high efficiency)

Energy consumed by high efficiency (replaced) pumps = 4x30=120 H.P.

No. of units saved = 90 units/hr. Cost of one unit in rupees = 3/KWH

Total cost recovered in a year = 3x90x24x365=Rs. 2365200

Thus 50% energy and thereby approximately 2.36 lakh Rs. can be saved.

1.3.2 *Barometric leg of Washers:*

Energy consumed by each pump = 60 H.P.,Total no. of pumps used = 2

No. of units saved = 90 units/hr,Cost of one unit in rupees = Rs 3/KWH

Total cost recovered in a year = 3x90x24x365 = 2365200 Rs.

So by removing the pumps the 100% energy can be saved thereby saving an amount of Rs 2.36 lakhs approximately annually.

1.3.3 *Agitators:* By providing interlock system in agitators the energy and cost saved is:

Unit cost of power=Rs 3/KWH,Power saved in a day=106.46 KWH/day

Estimated idle operation that could be avoided=1 hour/day

Annual saving=106.46x1x365x3=Rs116573.7

Energy saved =1x106.46 /106.46 x24=41.6%

1.3.4 *Dryer Head of Steam Cylinders*:

Total steam consumption in paper machines=17tph

Steam pressure = 3.5 kg/cm^2,Low pressure steam cost = Rs 121 per tone

By insulating dryer heads saving potential = 3.5% Annual operating hours = 8000

Annual saving = 17x.035x8000x121= Rs 5.75 lakhs

1.3.5 *Coal Fired Boilers:* In case of coal fired boilers

% blow down = (TDS in feed water/Max permissible TDS in boiler)x(%of makeup water)

TDS in feed water = 3000mg/L, Max permissible TDS in boiler water = 2500mg/L

% make up water = 41.6 litres so, % blow down = 0.5%

Temp of water = 200°C, Daily steam generation = 1500 tons

Total amount of demineralised water = 1500x0.5%=7.5 tons

Equivalent (H.P.) steam=2x200x (7.5/1500) = 2tons/day ,Total amount of steam saved in a year = 2x360=720

Equivalent coal saved=720x (1000/6000) = 120 kg/day, Cost of coal saved =120x 3.25 =Rs 390

Annual saving of coal (A) =Rs 1, 42,350

Cost of processing7.5 tons of dimineralised water (B) i.e saved= 7.5x15x365 = Rs 41062

Coal saved by avoiding scale formation(C) =2% of coal saved in a day

Annual saving (C) =RS3250x2.4x365=28, 47,000

Total saving=A+B+C=RS 30, 30,412/-

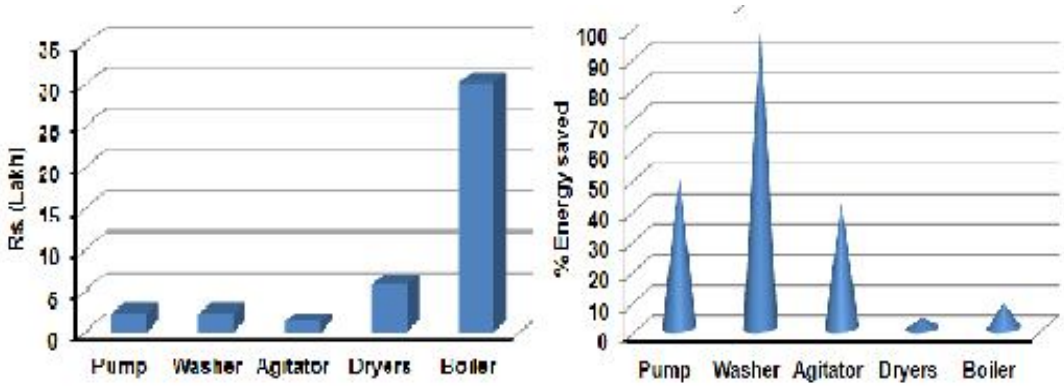

Fig. 1: Cost and Energy saving for the audited sections.

2. Conclusion and Recommendations

From the above case study it is found that old version pumps were consuming higher power. By applying same capacity but high efficiency pumps, it is observed that 50% of energy can be saved compared with old version pumps. After increasing the barometric leg height from 10 meters to 13 meters self suction of the black liquor from the washer vat is found possible eliminating the use of two vacuum pumps thus saving 100% cost and energy. Boilers have scaling problem which aggravates localized corrosion and affects the boiler life. So in boilers the manual blow down valve was replaced by TDS blow down valve resulting in 5% to 8% of fuel savings. It was observed that some of the agitators in the stock preparation were being run continuously so interlocks were being provided in order to save power. During the audit it was observed that dryer head of steam cylinders of the paper machine were not insulated thereby increasing heat loss from the dryer heads so it was recommended to insulate the heads to reduce energy consumption and investment cost for insulating (app. Rs. 2.0 lakh), can be paid back in 5-6 months.

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